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SOME COMMON FEATURES OF RETREAT LONGWALL PANELS IN HIGHLY PRODUCTIVE MINES

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SOME COMMON FEATURES OF RETREAT LONGWALL PANELS IN HIGHLY PRODUCTIVE MINES

by

G.A. Haslett* and D.B. Stewart**

SUMMARY

This report is a review of both the common and uncommon features of four highly productive mines. The first common feature that can be identified is that at each mine a single longwall retreat panel supported by productive and rapid development is the basis for outputs of approximately 1.5×10^6 tonnes saleable/annum.

Emergent also to common features is the use of heavy duty equipment that embodies a principle of over design to enhance equipment reliability. Where output depends on one face alone there must be a dedication to reliability.

There are however notable variations in both the depths of working, the working conditions and the proximate geology for each of the four mines. Futhermore one mine experiences methane emission levels of a high order which requires extensive drilling programmes for both predrainage and postdrainage for each longwall panel.

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QUELQUES CARACTÉRISTIQUES GÉNÉRALES DES PANNEAUX EXPLOITÉS PAR LONGUES TAILLES RABATTANTES DANS LES MINES HAUTEMENT PRODUCTIVES

par

G.A. Haslett* et D.B. Stewart**

RÉSUMÉ

Dans le présent rapport, on examine les caractéristiques générales ainsi que les caractéristiques particulières de quatre mines hautement productives. La première caractéristique générale qui peut être identifiée est que dans chacune des mines, un seul panneau exploité par longues tailles rabattantes suivi d'un développement rapide et productif est à la base d'une production d'environ $1,5 \times 10^6$ tonnes vendables par an.

L'utilisation d'un équipement robuste ressort aussi comme une des caractéristiques générales; cet équipement est conçu d'après un principe de conception qui vise à augmenter la fiabilité de l'équipement. Lorsque la productivité découle d'un front seulement, on se doit de miser sur la fiabilité.

Il existe cependant des variations remarquables au niveau de la profondeur de l'exploitation, des conditions de travail et de la géologie rapprochée de chacune des quatre mines. En outre, dans une des mines le taux des émissions de méthane est très élevé, ce qui nécessite d'importants programmes de forage pour le prédrainage et postdrainage de chaque panneau d'exploitation par longues tailles.

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INTRODUCTION

This report examines the equipment and the conditions of four highly productive longwall mines. Three of these mines are located within the state of W. Virginia in the United States of America and the fourth mine is located in the state of New South Wales in Australia. Each of these mines was visited during 1984/85 by one or other of the authors.

The reasons for high levels of productivity and production are accounted for in part by assumption. The assumptions that are made relate to good management, good labour relations, good teamwork and good mine planning. One of the fundamentals of good mine planning is the correct matching of the mining equipment to the system and conditions that will most likely be encountered within the mine. This report is an examination of those matches.

LOCATION OF THE MINES AND DETAILS OF EACH FACE

Table 1 identifies the mines by name, ownership and location. It also gives the name of the seam worked and the basic dimensions for each working panel. The heights of extraction given in this table for the Robinson Run, Mine 131 and Appin Colliery relate approximately to the extraction in total of the seam from roof to floor.

The height of extraction given for the Martinka Mine includes the removal by the shearer of approximately an average thickness of 0.61 m (2 ft) of floor clay and rock. This was necessary as the immediate floor rock/clay underlying the seam was both undulatory and soft. The average vend on the run of mine coal for the Martinka Mine was reported as 64%.

It is significant to this fact that Martinka has also the greatest panel width at 213 m (700 ft) to reduce proportionately shearer running time/shearer turn around time at the face ends and to reduce the costs of development for the mine. No problems of roof control were reported as a consequence of increased panel widths and Martinka Mine management is considering, presuming continued success, to go to an ultimate panel width of 305 m (1000 ft).

Table 1 also gives estimated daily saleable outputs, total daily work forces and outputs/person shift overall. This data has all been derived

in part from notes made during the discussion of each mine operation with the management at the respective mines.

The daily saleable outputs are a result of the contribution of clean coal produced at the mine. Martinka Mine is disadvantaged with respect to the other three because as previously mentioned there is present an average thickness of 0.61 m (2 ft) or rock/clay in the floor underlying the seam which had also to be removed in all entry drivages to ensure an even floor grade for tracklaying and transport requirements.

The three W. Virginian mines all had a pattern of four entry drivages each side of a longwall panel. The adoption of a four entry pattern makes available three entries on the loader gate side, each for the separate purposes of coal transport, material transport and personnel transport, while the fourth is reusable for the extraction of the next adjacent panel as a return airway. Four entries are generally considered by U.S. operators as the least number in which a continuous miner can be effectively utilised in a productive mode.

The distances between longwall panel entries for the W. Virginian mines varied between 24 m (80 ft) to 30.5 m (100 ft) each pattern employing equidistant centres with breakthroughs (cross-cuts) at distances of 30.5 m (100 ft) to 36.5 m (120 ft). Martinka and Mine 131 adopted four-way intersections at the breakthroughs (cross-cuts) for the middle entries with a square cut pattern. Robinson Run mine used three-way intersections at the breakthroughs (cross-cuts) leading at an angle of approximately 30° from the direction of the entry drivage. It is claimed that such a pattern makes for more effective utilisation of the continuous miners and shuttle car cycles and is therefore more productive than square cut breakthroughs. Counter claims repudiate the system as being neither safe nor practical where retreat extraction of pillars must be practised with continuous miners.

Robinson Run and Martinka both use four continuous miners to develop both main and subsidiary entries including those for longwall panels with the assurance of the development of replacement panels for continuous longwall operation. Mine 131 uses five continuous miners with a similar assurance. All three mines also had pillar extraction schemes by continuous miners at the irregular boundaries of the mines that were not amenable to longwall mining.

For development productivities, Appin Colliery is disadvantaged when compared to the W. Virginian mines inasmuch as each longwall panel is developed by only three entries on either side. Moreover, these entries were on average of widths of between 0.5 m (1.65 ft) less for the loader gate entry to 1.5 m (5 ft) less for the other entries (see Tables 5 and 6).

These three entries are driven on each side of a longwall panel at centres between the loader gate entry, width 5 m (16.4 ft) and the next inside entry width 4 m (13 ft) of 30 m (98 ft). The centre distances between the pair of 4 m (13 ft) width entries is 15 m (49 ft).

The dimensions and layout of these entries acknowledges the more difficult ground control conditions that prevail at Appin Colliery. Breakthroughs (cross-cuts) are put through at intervals of 100 m (320 ft) between the 5 m (16.4 ft) entry and the inside 4 m (13 ft) entry and at intervals of up to 120 m (394 ft) between the 4 m (13 ft) entries. All intersections formed from breakthroughs are three-way only.

Each outside entry of the 4 m (13 ft) width entries is reused as a return by the next consecutive longwall panel. The narrow chain pillars formed between the 4 m (13 ft) width entries serve as yield pillars to preserve each of the outside of these narrow entries for reuse as a return entry by the next adjacent longwall panel.

Discounting any revenue benefits from the utilisation of methane yielded from methane drainage, Appin Colliery is further disadvantaged with respect to the productivity levels of W. Virginian mines by the employment of additional crews for drilling, pipelaying and maintaining the methane drainage system.

The estimated daily saleable outputs, total daily work forces and outputs/person shift overall given in Table 1 have been derived taking into account the three respective mine layouts, transport systems, construction crew requirements, coal dilution and whether or not methane drainage is practised. Also taken into account is the face transfer times from a terminated longwall panel to a new one which is quoted as 12 days for Robinson Run up to 30 days for Mine 131.

Table 1 - Location, dimensions, estimated daily outputs and methane emissions from longwall panels

Name of Mine	Robinson Run	Martinka	Mine 131	Appin Colliery
Owner	Consolidation Coal Limited	Southern Ohio Coal Limited	Bethlehem Steel Corporation	B.H.P. Steel (Broken Hill Proprieties)
Location	Fairmont W. Virginia U.S.A.	Fairmont W. Virginia U.S.A.	Van W. Virginia U.S.A.	Illawara District N.S.W., Australia
Name of Seam Worked	Pittsburgh No. 8	Lower Kittanging	No. 2 GAS	Bulli
Width of Panel	152 m (500 ft)	213 m (700 ft)	165 m (540 ft)	175 m (575 ft)
Length of Panel	1585 m (5200ft)	1463 m (4800ft)	1646 m (5400 ft)	1450 m (4757 ft)
Height of Extraction	2.13 m (7 ft)	1.98 m (6.5 ft)	1.85 m (6 ft)	2.7 m (8.85 ft)
Methane Emission Levels	Not measured	Not measured	Not measured	48 m^3/tonne (1695 ft^3/ tonne) in the panel
Estimated Daily Saleable Output (tonnes)	7220	6650	7440	7010
Estimated Total Daily Work force	227	251	278	311
Estimated Output /Person Shift Saleable tonnes	28.8	23.9	26.7	22.5

SHEARERS USED AT EACH MINE

Table 2 gives details of the shearers that are operating at each mine. Shearers at three of the mines have both a common manufacturer and common approximate duties. The shearer at Appin Colliery has the additional refinement of radio control. Appin Colliery has a dedicated two-way radio system throughout the mine which has proved to be very beneficial in operational control and for emergencies.

The average daily production for Martinka would be enhanced to 6650 tonnes if all material cut and loaded by the shearer was included and not just the saleable output.

The average daily production at Mine 131 greatly exceeds those at the other three. It is a result of the machine operating in full cut in both directions on the face. It is able so to do because of general compliance with the U.S. federal law with regard to the production of long-term respirable dust which was not the case at the other two mines located in the state of W. Virginia. Dust suppression was provided on the shearer at Mine 131 by two open-ended sprays for each drum each delivering through a short square collimating tube of an internal dimension of 63.5 mm (2.5 in) and length 102 mm (4 in). One spray played across the pick array on each drum and the other spray was arranged to play around the delivery point of the drum onto the armoured face conveyor. The water consumption of these sprays amounted to 354 l/min (78 gal/min) at a delivered pressure to the shearer of approximately 17.2 bar (250 lbs/in^2). With the high volume of coal produced by this shearer 6.4 m^3/min (226 ft^3/min) no superfluous water was evident on the floor at the face.

The absence of airborne dust was partially assisted by the higher levels of inherent moisture, approximately 11%, that prevails within the No. 2 gas seam. The greater power requirement, 400 kw for the shearer at Mine 131, is reflected in its higher duty.

ARMOURED FACE CONVEYOR USED AT EACH MINE

Table 3 outlines the sizes and capacities of the armoured face conveyors at each mine. The 760 mm (30 in) was standard at each of the mines

Table 2 - Details of shearer operation including daily average outputs for the best month's output

Name of Mine	Robinson Run	Martinka	Mine 131	Appin Colliery
Shearer	Eickhoff EDW 300L D.E.R.D.	Eickhoff EDW 300L D.E.R.D.	Joy 3LS D.E.R.D.	Eickhoff EDW 200L D.E.R.D.
Shearer Power	300 kw (400 hp)	300 kw (400 hp)	400 kw (535 hp)	200 kw (270 hp)
Shearer Control	Manual	Manual	Manual	Radio Control
Shearer Haulage System	Eickotrac	Eickotrac	Dynatrac	Eickotrac
Shearer Operation	Cut from tailgate to maingate flit back	Cut from tailgate to maingate flit back	Bi-directional cut both ways	Cut from tailgate to maingate flit back
Average Daily Production tonnes for the best month's output	5660	4347	9029	5448*

* Average daily production for the best longwall panel.

Table 3 - Details of armoured face conveyors

Name of Mine	Robinson Run	Martinka	Mine 131	Appin Colliery
Conveyor Manufacturer	Halbach & Braun	Westfalia Lünen	Huwood Irwin	Westfalia Lünen
Conveyor Width	760 mm (30 in)	760 mm (30 in)	760 mm (30 in)	932 mm (37 in)
Conveyor Discharge to Stageloader	Side end on	Rollercurve	Side end on	Through side integrated with stageloader
Conveyor Chain	Twin inboard 26 mm	Single centre 38 mm	Twin inboard 30 mm	Twin inboard 30 mm
Conveyor H.P.	600	850*	600	800
Conveyor Capacity tonnes/hr	1000	1000	1000	1250
Stageloader H.P.	160	N/A	160	160

* Composite drive on A.F.C. and stageloader.

in W. Virgina with capacities of 1000 tonnes/hr. Twin inboard chains were favoured at three of the mines. The use of a twin chain was precluded at Martinka because the stageloader and the armoured face conveyor were indivisible through the use of a powered roller curve. There were evident benefits in such a system as it gave unobstructed access to the shearer to cut without interference to the leading drum into the loader gate entry and also kept the intersection of the face with the loader gate entry much cleaner than in the case where the delivery was side on as at Robinson Run and Mine 131.

The adoption of through side discharge integrated with the stageloader at Appin Colliery also had similar benefits to the roller curve.

The 932 mm (37 ins) width pan of the armoured face conveyor used at Appin Colliery would appear at first sight to be of a capacity (1250 tonnes/hr) far beyond the likely demands of output. However at a height of extraction of 2.7 m (8.9 ft) very large lumps sometimes burstoff immediately ahead of the shearer which demanded the extra width provided by the armoured face conveyor to enable their transport from the face to be completed.

Both the stageloader at Appin Colliery and Mine 131 were equipped with spillage plates of a height of 1.2 m (4 ft) and had lump breakers incorporated before their delivery onto the loader gate entry conveyor belt. The need for a lump breaker at Mine 131 was not a consequence of exceptionally large lumps of coal but was required to break occasional large slabs of immediate roof that detached before the supports could be moved over behind the shearer with their canopy tips close to the solid coal.

THE SUPPORT OF THE FACE AT EACH MINE

In Table 4 is setout some of the essential details for the face supports. The exception to the use of four-leg chock shields is the Robinson Run mine that uses two-leg shields. The seam in which this mine operates is the Pittsburgh No. 8 which is characterised throughout the states of Pennsylvania and W. Virginia by excellent mining conditions. The limitation of two-legged chocks is acknowledged inasmuch as the value of setting pressure was 75% of that of the yield pressure to ensure that there was an adequate vertical force component applied to the immediate roof each time

Table 4 - Details of face supports

Name of Mine	Robinson Run	Martinka	Mine 131	Appin Colliery
Type of Support and Manufacturer	505 tonnes, two-leg shield, Gullick Dobson	630 tonnes, four-leg chock shield, Gullick Dobson	725 tonnes, four-leg splayed chock shield, Dowty	628 tonnes, four-leg splayed chock shield, Westfalia Lünen
Mode of Operation	One web back	One web back	One web back	One web back
Design of Front Canopy	Rigid integral with rear canopy	Rigid integral with rear canopy	Rigid integral with rear canopy	Rigid integral with rear canopy
Front Canopy Telescopic Powered Face Sprags	No	No	No	No
Support Control	Adjacent bi-di with automatic control in batches of 10	Adjacent bi-di with automatic control in batches of 6	Adjacent bi-di manual	Adjacent bi-di with automatic control in batches of 8
Setting Pressure	276 bar (4000 psi)	330 bar (4800 psi)	310 bar (4500 psi)	320 bar (4640 psi)
Yield Pressure	366 bar (5300 psi)	504 bar (7300 psi)	517 bar (7500 psi)	500 bar (7250 psi)
Ratio $\frac{\text{Setting Pressure}}{\text{Yield Pressure}}$	75%	66%	60%	64%
Hydraulic Pumps Used For Supports	3 Hauhinco 2 operating 1 spare	3 Hauhinco 2 operating 1 spare	3 Hauhinco 2 operating 1 spare	3 Hauhinco 2 operating 1 spare
Face Lighting Units Incorporated in Supports	Yes	Yes	Yes	Yes

that the supports were reset. The range of setting pressures for the four-leg chock shields was between 60% - 66% of the yield pressures.

The three mines other then Robinson Run had each encountered problems with the control of their roofs. There are variations in the depths of cover from an exceptional low at Martinka of 107 m (351 ft) to 550 m (1800 ft) at Appin Colliery with Mine 131 experiencing variations between 244 m (800 ft) to 400 m (1310 ft).

The visit to Martinka was timely as the face had just passed under a zone of minimum depth of cover. This minimum depth of cover was 107 m (351 ft) and was the result of the face passing under a local deeply incised river valley. The caving of the thick mudstone roof in the goaf behind the powered supports was massive and was lying in a compacted condition on their goaf shields.

Water was already starting to percolate into the goaf and tended to confirm the statement made by mine management that the time dependency for the start of surface subsidence with such shallow working was in hours rather than days. The response of the face crew to these conditions was very objective with reassurances that it would only delay marginally the next few moveovers of the face.

The supports on the face at Mine 131 had, at the time of the visit, the distinction of being one of the two installations throughout the U.S.A. with the heaviest load rating (725 tonnes) 800 U.S. tons.

The timing of the visit was also opportune as the depth of cover where the face was currently working was coincident with a recognised problem of roof control. The problem occurs between depths of cover of 244 m (800 ft) to 308 (1000 ft) when there is a thinning of the friable shales that form the immediate roof to thicknesses of <12 m (40 ft). Above such shales lies a massive bed of sandstone of thickness of some 15.2 m (50 ft).

The characteristic of working longwall panels under such conditions is the development of heavy front abutment pressures due to the folding down of the sandstones in the goaf area behind the face rather than stress relief that is afforded from measures of lesser yield strengths that fracture more easily and cave.

There can be relief of strain energy in the front abutment zone provided that any softer rocks that are subjacent to massive sandstone beds

are of sufficient thickness and volume to absorb the strain energy created in compressional stress by the massive sandstones.

The problem of working under such a roof is the control of localised failures in zones where the roof slabs off just ahead of the shearer with some of the slabs being in lengths of 1.8 m (6 ft) to 3 m (10 ft) and of thickness up to 0.45 m (1.5 ft).

The control of the supports at Mine 131, although being adjacent bi-di, were not equipped for automatic batch control as at the other three mines. A system of automatic control from a microprocessor response to the shearer is under consideration for future operation at an appropriate time at Mine 131.

The heavy load rating of these supports was in acknowledgement of the massive sandstone beds that lie above the immediate shale roof at Mine 131.

The roof at Appin Colliery replicates some of the problems that occur at Mine 131 being also of friable shales overlain by massive sandstones.

A feature again common to all four mines was the provision of three Hauhinco type EHT 3K 90/45 pumps for each face to service the hydraulic supports and rams. Two such pumps were kept operating constantly and one was kept on standby.

SUPPORT OF LOADER GATE ENTRIES

The depth of cover for the Bulli Seam at Appin Colliery is 550 m. The working heights of the Bulli Seam varies between 2.4 m - 3.4 m. The immediate roof is shale. The mine has been operating for 23 years.

Up until 1982 closely set steel supports was the predominant support pattern for roadways in the mine. Since 1982 high strength roof bolts with long encapsulated chemical anchors has become the pattern. More recently, there has been a transition in the supports of ribs for the permanent pillars from the use of wooden props to 20 mm diameter bolts or 16 mm diameter wriggle bolts fastening steel straps. For the rib sides that form the edges of the longwall panels 19 mm x 1200 mm (0.75 in x 48 in) chemically anchored fibreglass dowels are used with wooden plates of dimensions

(0.3 m x 0.9 m) (1 ft x 3 ft) set at intervals not exceeding 1.0 m. The use of such dowels and plates does not interrupt in the operation of the shearer which can cut directly through to the rib at the face ends into either the loader gate or return entries.

Table 5 is a summary of details of roof and rib bolting procedures in the loader gate entries at the four mines. The combination of greater depths of cover with greater exposed heights of rib predicate heavier support measures for Appin Colliery. The roof support of the entries is a 6 bolt per row square pattern at 1 m centres (3.28 ft) of 2.43 m (8 ft) long bolts with 1.82 m (6 ft) encapsulation. Rib support is provided by either one or two rows of steel straps 2.5 long (8.2 ft) x 0.3 wide (1 ft) anchored by 1.2 m (4 ft) bolts at 0.8 m (2.66 ft) centres.

The W. Virginian mines conformed to a standard square set pattern of high strength bolts for the support of the roof at 1 m (3.28 ft) centres with either 1.2 m (4 ft) (Robinson Run and Mine 131) or 1.5 m (5 ft) (Martinka). The anchors were mostly total encapsulation.

At depths not exceeding 400 m (1300 ft) and seams not exceeding 2 m (6.5 ft), rib support was generally not needed excepting in the front abutment zones of the loader gate entries where rib posting with lagging was practised.

No further temporary or other support is necessary in the front abutment zone at Appin Colliery which is a tribute to the permanent support systems provided for the roof and ribs.

Of the three W. Virginian mines Martinka was the only mine that practised systematic support of the roof in the front abutment zone in the loader gate entry by moving forward regularly four rows of 20 ton rating hydraulic props, 4 props/row.

Mine 131 systematically set a row of wooden props at 1.2 m (4 ft) centres across the first crosscut from the face to the manway entry as the face retreated.

SUPPORT OF TAILGATE ENTRIES

Reference to Table 6, details of return gate entry support, indicates a similarity of dimensions and method of support to that practised in

Table 5 - Details of loader gate entry support

Name of Mine	Robinson Run	Martinka	Mine 131	Appin Colliery
Loader Gate Entry Width	5.5 m (18 ft)	5.5 m (18 ft)	5.5 m (18 ft)	5 m (16.4 ft)
Length of Roof Bolt Used	1.2 m (4 ft)	1.5 m (5 ft)	1.2 m (4 ft)	2.43 m (8 ft)
Roof Bolt Anchorage	Full column, resin bonded	Full column, resin bonded	Full column, resin bonded	1.82 m (6 ft) column, resin bonded
Roof Bolt Plates	Square dimple 0.15 m (0.5 ft)	Square dimple 0.15 m (0.5 ft)	Square dimple 0.15 m (0.5 ft)	Square domed 0.1 m (0.33 ft)
Roof Bolt Centers	Square pattern 1.2 m (4 ft)	Square pattern 1.2 m (4 ft)	Square pattern 1.2 m (4 ft)	Square pattern 1 m (3.28 ft)
Rib Support	Rib posting with lagging in front abutment zone	Rib posting with lagging in front abutment zone	Rib posting with lagging in front abutment zone	-Steel straps, 2.43 m long (8.0 ft), 0.3 m wide (1 ft) -4 bolts/straps, 0.8 m (2.66 ft) centers -1 row in top half of coal or 2 rows set at half and three quarters distance from the floor *See pp 11 and 12 for details of face side rib support
Front Abutment Support	Random wooden posts as necessary	Four rows - four props/ row 20 ton hydraulic	One row of wooden props either side of the stageloader	No additional support found to be necessary to existing roof and rib support

Table 3 - Details of return gate entry support

Name of Mine	Robinson Run	Martinka	Mine 131	Appin Colliery
Return Gate Entry Width	5.5 m (18 ft)	5.5 m (18 ft)	5.5 m (18 ft)	4 m (13.1 ft)
Length of Roof Bolt Used	1.2 m (4 ft)	1.5 m (5 ft)	1.2 m (4 ft)	2.43 m (8 ft)
Roof Bolt Anchorage	Full column, resin bonded	Full column, resin bonded	Full column, resin bonded	1.82 m (6 ft) column, resin bonded
Roof Bolt Plates	Square dimple 0.15 m (0.5 ft)	Square dimple 0.15 m (0.5 ft)	Square dimple 0.15 m (0.5 ft)	Square domed 0.1 m (0.33 ft)
Roof Bolt Centers	Square pattern 1.2 m (4 ft)	Square pattern 1.2 m (4 ft)	Square pattern 1.2 m (4 ft)	1 m (3.28 ft) between rows, 0.8 m (2.66 ft) between bolts in a row
Rib Support	Rib posting and lagging if necessary	Rib posting and lagging if necessary	Rib posting and lagging if necessary	-Steel straps, 2.43 m long (8.0 ft), 0.3 m wide (1 ft) -4 bolts/straps, 0.8 m (2.66 ft) centers -1 row in top half of coal or 2 rows set at half and three quarters distance from the floor *See pp 11 and 12 for details of face side rib support
Chocking to Maintain Airway for Goaf Ventilation	1 row of 1.5 m (5 ft) hardwood chocks at 2.43 m (8 ft) centers	1 row of 1.83 m (6 ft) hardwood chocks at 2.43 m (8 ft) centers	2 rows of 1.2 m (4 ft) hardwood chocks at 2.43 m (8 ft) centers set at 1 m (3.28 ft) from each rib	N/A

the corresponding loader gate entries of the three mines located in W. Virginia.

At Appin Colliery the width of the return gate entry is 4 m (13.1 ft) being 1 m (3.28 ft) less than the loader gate entry. The roof bolt lengths and anchorages are similar to those in the loader gate entry. The pattern is 0.8 m (2.66 ft) between each bolt in a row and 1.0 m (3.28 ft) between rows. The rib bolting pattern is similar to that practised in the loader gate entry.

The return gate entries at the Robinson Run, Martinka and Mine 131 follow the standard practice of having hardwood chocks (cribs) built throughout their length before the panel retreats. This is done to retain such entries for leakage ventilation of the goaf area, a requirement of U.S. federal law. No such provision was made at Appin Colliery as there is no state or federal law requiring such a practice.

There is not in place within the Appalachian coalfield, excluding the state of Alabama, any dedicated schemes to systematic methane drainage.

The support pattern of hardwood chocks was more dense at both Martinka and Mine 131 than at Robinson Run. The 1.83 m (6 ft) hardwood chocks used at Martinka were offset from the centres of the entry to within about 1 m (3.28 ft) of the face ribside. The last support on the face carried an additional side shield to prevent the encroachment of the cave in the return gate onto the face as there was a systematic caving of the roof from the face ribside up to the edge of the line of chocks. Conditions between the chock and the far ribside appeared to remain fairly stable as far back as vision allowed. Mine 131 made use of a double line of chocks. This greater chock density did not however prevent limited local spalling of the roof between each row of chocks or between the chocks in a row.

METHANE DRAINAGE AT APPIN COLLIERY

In July 1979 an explosion occurred in a three heading development panel at Appin Colliery which resulted in the deaths of fourteen men. From the outcome of this explosion came a requirement by law that an adequate methane drainage system be installed and monitored at the Colliery. There is now in place a comprehensive and systematic drainage scheme that is monitored

throughout and is connected to an automated surface plant that comprises seven water seal pumps each of a capacity of 720 1/sec. The total plant flow is currently 3200 1/s at a purity of 74% CH_4.

The predrainage scheme for the last longwall panel to be extracted demanded the drilling of sixty-seven 50 mm diameter (2 in) in seam holes, whilst the postdrainage scheme for the same panel demanded the further drilling of seventeen 50 mm diameter (2 in) upholes at an inclination of 25° to a total distance for all upholes of 1261 m (4137 ft), and an additional one hundred 50 mm diameter (2 in) downholes inclined at 18° to a total distance for all downholes of 10,582 m (34,720 ft). The recorded gas make/tonne for this panel was 48 m^3 (1675 ft^3). Testimony to the success of the methane drainage scheme is given by the reductions in return airway CH_4 levels from typical values of 1.5% - 2.5% to 0.9% - 1.3% and typical values on the face of 0.4%.

FACE LIGHTING

All four mines visited had lighting unit sets incorporated in the rear portions of the chock shield or shield supports. The benefits of face lighting are very apparent when a face is clearly visible throughout its length. The control of the face is made easier, more particularly the alignment, and the control exercised on all the faces was excellent being greatly assisted by the provision of face lighting.

ROADWAY DRIVAGE

The need to ensure that replacement longwall panels were made available and suitably prepared before any existing longwall panel was terminated was acknowledged and fulfilled at all of the four mines visited in this report.

The question of productivity and viability of the development of the mine was also addressed. As a precept the development costs should not be greater than a "break even" position.

To keep abreast with development, Appin Colliery employed six continuous miners. These continuous miners were constrained from producing at comparable rates to those employed at the W. Virginian mines by more rigourous ground control measures that had to be adopted and that demanded lesser number of entries than an optimum for more productive operation, lesser entry widths and extended breakthrough distances. This combination of constraints increases haul distances of shuttle cars from the continous miners to the feeder/breakers inhibits maneuvrability and increases the tasks of the crews with the need for additional and longer rock bolt patterns to support the roof and ribs.

The estimated average productivity for Appin's continuous miner crew is 13 tonnes/manshift. The estimated average productivity for similar crews employed at Robinson Run mine is 22 tonnes/manshift. This represents an increased productivity of approximately 69% for Robinson Run and by inference a need for only four continuous miners.

If Mine 131 is included in the comparison, then again by inference the need to employ five continuous miners is evident from the life of the working panels at each mine which were stated to be of an order of 100 days compared with a life of 124 days for Robinson Run.

FACE MOVES

With multiple entries face moves have been accomplished at some U.S. mines in periods of no more than 2 days (1). Discussions on this topic was limited at the mines that were visited but the periods covered were reported to be from 12 days at Robinson Run to 30 days at Mine 131. These figures, it is believed, relate to the last longwall panel transfer undertaken at the respective mines and did not represent a target figure.

The downtime of longwall faces has an adverse effect on the productivity of mines and is illustrated in Table 1 where, to arrive at the figures given, an assumption was made that the longwall panel underwent two transfers at Mine 131 during the year for which the estimates of overall production were made. For the other mines only one transfer was assumed each year.

Accepting these assumptions, a clear illustration is given of the result of protracted change over times in the transfer of longwall equipment as the productivity is only marginally enhanced in spite of the much greater face productivities that could be attained with the heavy duty shearer cutting both ways as it did at Mine 131.

If the performance for the month reported could be maintained on a regular basis at Mine 131, this would reduce the life of a working panel of length 1646 m (5400 ft) to 70 days instead of the reported 100 days. The current reason for not making quicker moves at Mine 131 is believed to result from limited coal sales to an oversupplied market.

Four or an even greater number of entries, each side of a longwall panel has obvious and apparent benefits when transferring longwall equipment as the loader gate entry conveyor belt used previously in a centre entry for the development of the entry pattern can be transferred and assembled without interference to a one-way traffic circulation in the two centre entries bringing in the face equipment for the longwall panel. Shunt and drop off facilities are provided in the entry remote from the longwall panel.

CONCLUSION

Mining is an old and honourable occupation. From the course of its long and recorded history has come many maxims, adages, truisms and indeed trite sayings. Among such, at this time, two such sayings are particularly recalled. One is "good conditions make good miners" and the other is "when you have rough conditions you have to treat them rough(ly)".

This report covers visits in which both concepts might be included. The import of the latter saying has changed dramatically during the last forty years. Forty years ago, by implication, it demanded great physical effort upon part of the work force. At present time the implication has changed and the response to rough conditions now demands careful judgement, a knowledge of advanced technology and an ability to match equipment and systems to correct responses. It is now a matter in the domain of the thoughtful rather than the physical.

REFERENCES

1. L.J. Mills and K. Jones "Visit to Blacksville No. 2, Loveridge and Ireland Mines"; Mining Engineer; Vol 144, No. 281; 1985.